

Evaluation of Chilli (*Capsicum annum* L.) Genotypes in the Sundarban Region of West Bengal

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Abstract

Screening of chilli genotypes for yield related traits and leaf curl tolerance has become imperative in the Sundarban region of West Bengal because of the dwindling yield pattern in the recent years. An attempt was made to collect the indigenous genotypes and test their compatibility in the prevailing environment. High heritability coupled with good amount of genetic advance was observed for total fresh yield per plant, number of seeds per fruit, ascorbic acid content and days taken to 50% flowering. Rest of the traits inclusive of capsaicin content was controlled by non-additive genes. Total fresh yield per plant exhibited significant association with number of fruits per plant and fresh weight of fruit. Path studies revealed that stress should be laid on number of seeds per fruit, number of fruits per plant and fresh weight of fruit while selecting the promising accessions. Among the genotypes, BCC-28 (18) and Ankur 228 were found to be resistant towards leaf curl complex.

Key words : Genetic variability, Leaf-curl complex, Chilli genotypes, Sundarbans, Yield traits.

Chilli is an important vegetable and spice crop of India which has a good export demand. Chilli has acceptable tolerance towards salinity and this crop has been widely accepted by the farmers of Sundarbans as an important commercial crop since long time back. However, repeated growing of the same cultivar for several years in tandem has resulted in yield stagnation and yield depletion. Under this situation it is imperative to search for a promising cultivar for this region which will cater to the livelihood of the farmers involved with this crop. Mostly the emphasis is on green chillies having higher level of pungency and tolerance towards leaf curl complex. Yield being a polygenic character is largely influenced by environmental fluctuations. For a better understanding the degree of variability and correlation under a set of environmental condition should be ascertained. Further, partitioning of correlation coefficient into direct and indirect effect may prove useful for effective selection of the characters in relation to yield or related biotic and abiotic stresses.

Methods

In the present investigation the field work was

carried out at Ramkrishna Ashram KVK Instructional Farm, Nimpith, South 24 Parganas, West Bengal and the laboratory related tasks along with computation were undertaken in the Department of Horticulture, University of Calcutta. Thirty different genotypes collected from Sundarban region and from other places were transplanted by the end of November, 2007. The source of the genotypes are described in Table 1. The experiment was laid out in randomized block design having three replications. Fifteen plants of each genotypes were maintained in a plot at a plant spacing of 60 cm × 45 cm.

Observations were recorded on five representative plants selected randomly from each replication on the following set of characters viz. plant height (cm), number of primary branches per plant, days taken to 50% flowering, days from fruit set to maturity, fruit length (cm), fruit girth (cm), pedicel length (cm), number of fruits per plant, fresh weight of fruit (g), total fresh yield per plant (g), dry weight of fruit (g), number of seeds per fruit, capsaicin content (mg/100 g fruit) and ascorbic acid content (mg/100 g fruit).

Incidence of leaf curl complex was recorded in the entire plant population of each progeny and

Table 1. Source of the genotypes under study.

Genotype	Source	Genotype	Source	Genotype	Source
BCC-12 (sel)	BCKV, Kalyani, WB	KES-2013	AAU, Jorhat, Assam	Kuyemuri	Local collection from Kuyemuri island, 24 Pgs (S)
BCC-15 (30)	do	Krishna Small	do	Dalkhola-1	Local collection from Dalkhola, Uttar Dinajpur, WB
BCC-27 (28)	do	KA-2	do	Dalkhola-2	do
BCC-28 (int)	do	Morigaon Jhalakia	Local collection from Morigaon, Assam	Dalkhola-3	do
BCC-28 (18)	do	Wonder Hot	Local collection from Nagaland	Dalkhola-4	do
BCC-30	do	Canning Bullet	Local collection from Canning, 24 Pgs (S) WB	Ankur-228	Ankur Seed Company, WB
BCC-49 (42)	do	Aminpur Bullet	Local collection from Aminpur, 24 Pgs (N), WB	Baddy-304	Baddy Seed Company, AP
BCC-49 (var)	do	KVK-1	Selection by KVK, Nimpith, WB	Roshni	Sungro Seeds Ltd
BCC-54(sel)	do	KVK-2	Selection by KVK, Nimpith, WB	Teja	Beejo Sheetal Seeds Pvt. Ltd
BCC-61	do	Damkal	Local collection from Damkal island, 24 Pgs (S), WB	Goli	Amtala Seed Stores, WB

intensity of disease was worked out following the scale devised by Banerjee and Kalloo (1). The capsaicin content and ascorbic acid content were estimated following Anan et al. (2) and AOAC (3) respectively. The analysis of variance and covariance were carried out following standard procedures using biometric software SPAR—1 (IASRI, Pusa, New Delhi).

Results and Discussion

Wide range of variability persisted among the

characters under study (Table 2). The PCV was higher or similar to the corresponding GCV for all the traits justifying that selection would be more effective on the basis of phenotypic characters with equal probability of success. Among the quantitative traits, the PCV and GCV values were higher for the traits like fruit length, average fresh weight of the fruit, number of seeds per fruit and capsaicin content. A higher PCV and GCV value for the trait capsaicin content was also recorded by Ananthaswami et al. (4) Khurana et al. (5) and Nandi (6) observed low level of PCV

Table 2. Estimate of mean, range, variability, heritability (bs), genetic advance and genetic advance as percent of mean for yield and related characters.

Parameters	Plant height (cm)	No. of primary branches	Days taken to 50% flowering	Days from fruit set to maturity	Fruit length (cm)	Girth of the fruit (cm)	Pedicel length (cm)
Grand mean	43.397	8.559	59.060	34.714	5.058	3.394	3.501
Range	30.87–62.57	5.44–11.21	35.67–73.67	25.44–42.22	2.15–8.88	1.75–6.02	1.86–5.04
GCV	17.12	12.74	19.72	14.02	29.62	20.86	17.34
PCV	18.84	24.35	20.05	14.90	32.26	23.70	19.99
Heritability (h ²) %	82.58	27.37	96.67	88.46	84.31	77.45	75.13
Genetic advance	13.91	1.18	23.57	9.43	2.82	1.28	1.08
GA as % of mean	32.06	13.79	39.91	27.17	55.84	37.76	30.86

Table 2. Continued.

Parameters	No. of fruits per plant	Fresh weight of fruit (g)	Fresh yield per plant (g)	Dry weight of fruit (g)	No. of seeds per fruit	Capsaicin content (mg/100 g fruit)	Ascorbic acid content (mg/100 g fruit)
Grand mean	38.924	2.788	105.591	0.90	67.00	0.603	96.00
Range	25.33–56.00	1.51–4.10	69.39–162.44	0.50–1.37	35.00–95.78	0.23–0.98	62.03–139.95
GCV	18.55	28.36	23.67	19.96	30.39	31.08	19.39
PCV	19.47	30.69	23.75	31.23	30.50	32.01	22.46
Heritability (h ²) %	90.75	85.41	99.30	40.88	99.26	94.11	74.51
Genetic advance	14.25	1.51	51.55	0.24	41.79	0.37	33.49
GA as % of mean	36.61	54.12	48.70	26.67	62.37	61.67	34.89

value with respect to capsaicin content. Low to moderate level of PCV and GCV values were observed for traits like plant height, days taken to 50% flowering, days from fruit set to maturity, girth of the fruit, pedicel length, number of fruits per plant, fresh yield per plant and ascorbic acid content which are in accordance to the findings of Sree Lathakumary and Rajamony (7). It implies that these traits will show low

variability if recombinants are produced. Higher PCV values with corresponding lower values of GCV were recorded for two characters viz. number of primary branches per plant and dry weight of fruits.

The magnitude of heritability in broad sense was high for plant height, days taken to 50% flowering, days from fruit set to fruit maturity, fruit length, girth

Table 3. Phenotypic and genotypic correlation coefficients among different characters of Chilli. ** and * indicates significance at 1% and 5% level respectively. $r > 0.255$ and $r > 0.331$ are significant at 5 and 1% level of significance respectively.

		No. of primary branches	Days taken to 50% flowering	Days from fruit set to maturity	Fruit length (cm)	Girth of the fruit (cm)	Pedicel length (cm)	No. of fruits per plant
Plant height (cm)	P	0.191	0.206	0.322**	0.417**	0.202	0.235	0.089
	G	0.383**	0.237	0.401**	0.501**	0.244	0.287*	0.078
No. of primary branches	P		0.185	0.104	0.171	0.091	0.020	-0.004
	G		0.400**	0.148	0.309*	0.255*	-0.054	0.042
Days taken to 50% flowering	P			0.306*	0.253	0.177	-0.166	0.096
	G			0.328*	0.280*	0.181	-0.199	0.111
Days from fruit set to maturity	P				0.380**	0.104	0.175	0.166
	G				0.457**	0.098	0.259*	0.210
Fruit length (cm)	P					0.120	0.313*	0.110
	G					0.158	0.350**	0.125
Girth of the fruit (cm)	P						0.097	-0.023
	G						0.136	-0.034
Pedicel length (cm)	P							0.027
	G							0.033
No. of fruits per plant	P							
	G							
Fresh weight of the fruit (g)	P							
	G							
Yield per plant (g)	P							
	G							
Dry weight of fruit (g)	P							
	G							
No. of seeds per fruit	P							
	G							
Capsaicin content (mg)/100 g fruit	P							
	G							

Table 3. Continued.

		Fresh weight of the fruit (g)	Yield per plant (g)	Dry weight of fruit (g)	No. of seeds per fruit	Capsaicin content (mg)/100 g fruit	Ascorbic acid content (mg)/100 g fruit)
Plant height (cm)	P	0.389**	0.220	0.221	0.202	0.185	0.219
	G	0.435**	0.233	0.299*	0.225	0.219	0.235
No. of primary branches	P	0.310*	0.028	0.132	0.320*	0.154	0.189
	G	0.660**	0.035	0.378**	0.613**	0.228	0.510**
Days taken to 50% flowering	P	0.280*	0.169	0.279*	0.245	-0.086	0.234
	G	0.318*	0.173	0.468**	0.248	-0.087	0.291*
Days from fruit set to maturity	P	0.352**	0.006	0.119	0.319*	-0.040	0.228
	G	0.388**	0.005	0.376**	0.339**	-0.044	0.273*
Fruit length (cm)	P	0.482**	0.181	0.306*	0.386*	0.257*	0.154
	G	0.563**	0.197	0.562**	0.429**	0.299*	0.196
Girth of the fruit (cm)	P	0.292*	0.144	0.109	-0.024	0.190	-0.062
	G	0.326*	0.167	0.136	-0.026	0.234	0.063
Pedicle length (cm)	P	0.159	0.096	0.099	-0.048	0.072	-0.034
	G	0.212	0.118	0.003	-0.048	0.072	0.008
No of fruits per plant	P	0.062	0.739**	0.134	-0.124	0.084	-0.149
	G	0.073	0.780**	0.078	-0.128	0.086	-0.190
Fresh weight of the fruit (g)	P		0.303*	0.517**	0.611**	-0.143	0.129
	G		0.326*	0.802**	0.668**	-0.138	0.090
Yield per plant (g)	P			0.189	0.021	0.100	-0.153
	G			0.289*	0.021	0.101	-0.185
Dry weight of fruit (g)	P				0.347**	-0.081	0.173
	G				0.550**	-0.144	0.215
No. of seeds per fruit	P					-0.142	0.381**
	G					-0.151	0.444**
Capsaicin content (mg)/100 g fruit	P						0.043
	G						0.035

of the fruit, pedicle length, number of fruits per plant, average fresh weight of the fruit, total fresh yield per plant, number of seeds per fruit, capsaicin content and ascorbic acid content while it was moderate for dry weight of the fruit (Table 2). The least heritable estimate was observed for number of primary branches per plant (27.37%). Observations suggest that selection based on PCV would be more reliable. Similar results were also reported by Arya and Saini (8) and Sree Lathakumary and Rajamony (7). High heritability coupled with high to moderate genetic advance is more important than heritability alone in predicting resultant effect for selecting the best individuals. High heritability coupled with good amount of genetic advance was observed for total fresh yield per plant (h^2 99.30, GA 51.55), number of seeds per fruit (h^2 99.26 GA 41.79), ascorbic acid content (h^2 74.51, GA 34.49) and days taken to 50% flowering (h^2 96.67, GA 23.57). It indicates that these traits are controlled by additive gene action and offers the most

effective criteria for selection. High heritability with low genetic advance were observed for plant height, days from fruit set to maturity, fruit length, girth of the fruit, pedicle length, number of fruits per plant, average fresh weight of the fruits and capsaicin content indicating that these traits are mostly controlled by non-additive genes ; either dominant or epistatic. Improvement can be made here by intermating the superior genotypes and desirable genes can be accumulated. Similar findings have been recorded by Varalakshmi and Haribabu (9) and Chandra et al. (10).

The present study revealed that total fresh yield per plant was having positive and significant correlation with number of fruits per plant and fresh weight of the fruit at both genotypic and phenotypic levels (Table 3). However, total fresh yield per plant exhibited significant and positive association with dry weight of the fruit at genotypic level only. Our findings are partially similar to those of Gupta and Yadav

(11), who suggested that individual fruit weight does not play paramount role in increasing the total yield. It was also revealed that the table values of “rg” were higher than “rp” for all the traits thus justifying strong inferent association among the pair of characters at genotypic level. Path coefficient analysis based on simple phenotypic and genotypic correlations was done using total fresh yield per plant as dependent variable (effect) and 13 other characters as independent variables (causes). The phenotypic path analysis (Table 4) revealed that the highest and positive contributor towards total fresh yield per plant was exhibited by number of seeds per fruit (0.895) followed by number of fruits per plant (0.755), fresh weight of the fruit (0.424), days to 50% flowering (0.154), plant height (0.127), capsaicin content (0.087) and pedicel length (0.081). Similar findings have been reported by Dutta et al. (12). It indicates that for selecting high yielding chilli genotypes, stress should be laid more

on number of seeds per fruit and number of fruits per plant and fresh weight of the fruit. Residual effect (0.2638) of the path analysis of the present investigation was low suggesting the inclusion of maximum yield influencing characters in the analysis. Genotypic path showed that the maximum direct and positive contribution on total fresh yield per plant was through number of seeds per fruit (1.532) followed by dry weight of the fruit (0.735) number of fruits per plant (0.669), number of primary branches per plant (0.309), fruit girth (0.240) and plant height (0.189). Under both the paths, negative effect on total fresh yield per plant was manifested through days from fruit set to maturity, fruit length and ascorbic acid content. However, traits like fresh weight of the fruit, capsaicin content and days taken to 50% flowering showed negative path values at genotypic level though the same set of characters exhibited positivity with total fresh yield per plant in phenotypic path.

Table 4. Phenotypic and genotypic path values in different genotypes of chilli (dependent variable—total fresh yield/plant). Residual effect = 0.2638 (P) and 0.1572 (G).

Traits		Plant height (cm)	No. of primary branches	Days taken to 50% flowering	Days from fruit set to maturity	Fruit length (cm)	Girth of the fruit (cm)	Pedicel length (cm)
Plant height (cm)	P	0.127	-0.016	0.032	-0.088	-0.037	0.006	0.019
	G	0.189	0.118	-0.027	-0.061	-0.071	0.059	0.015
No. of primary branches	P	0.024	-0.082	0.028	-0.028	-0.015	0.003	0.002
	G	0.072	0.309	-0.046	-0.022	-0.044	0.061	-0.003
Days taken to 50% flowering	P	0.026	-0.015	0.154	-0.081	-0.022	0.006	-0.013
	G	0.045	0.123	-0.116	-0.05	-0.04	0.044	-0.011
Days from fruit set to maturity	P	0.042	-0.009	0.047	-0.264	-0.033	0.003	0.014
	G	0.076	0.046	-0.038	-0.152	-0.065	0.024	0.014
Fruit length (cm)	P	0.053	-0.014	0.039	-0.101	-0.088	0.004	0.025
	G	0.095	0.095	-0.032	-0.069	-0.142	0.038	0.019
Girth of the fruit (cm)	P	0.026	-0.007	0.027	-0.028	-0.011	0.031	0.008
	G	0.046	0.079	-0.021	-0.015	-0.023	0.240	0.007
Pedicel length (cm)	P	0.03	-0.002	-0.026	-0.046	-0.028	0.003	0.081
	G	0.054	-0.017	0.023	-0.039	-0.05	0.033	0.054
No. of fruits per plant	P	0.011	0	0.015	-0.044	-0.01	-0.001	0.002
	G	0.015	0.013	-0.013	-0.032	-0.018	-0.008	0.002
Fresh weight of the fruit (g)	P	0.05	-0.025	0.043	-0.093	-0.042	0.009	0.013
	G	0.082	0.204	-0.037	-0.059	-0.08	0.078	0.011
Dry weight of fruit (g)	P	0.028	-0.011	0.043	-0.031	-0.027	0.003	0.008
	G	0.057	0.117	-0.054	-0.057	-0.08	0.033	0
No. of seeds per fruit	P	0.026	-0.026	0.038	-0.084	-0.034	-0.001	-0.004
	G	0.042	0.189	-0.029	-0.052	-0.061	-0.006	-0.003
Capsaicin content (mg/100 g fruit)	P	0.024	-0.013	-0.013	0.01	-0.023	0.006	0.006
	G	0.041	0.07	0.01	0.007	-0.043	0.056	0.004
Ascorbic acid content (mg/100 g fruit)	P	0.028	-0.015	0.036	-0.06	-0.013	-0.002	-0.003
	G	0.044	0.158	-0.034	-0.041	-0.028	-0.015	0

Table 4. Continued.

		No. of fruits per plant	Fresh weight of the fruit (g)	Dry weight of fruit (g)	No. of seeds per fruit	Capsaicin content (mg)/100 g fruit	Ascorbic acid content (mg)/100 g fruit
Plant height (cm)	P	0.067	0.165	-0.02	0.181	0.016	-0.011
	G	0.052	-0.136	0.22	0.345	-0.048	-0.048
No. of primary branches	P	-0.003	0.131	-0.012	0.287	0.013	-0.009
	G	0.028	-0.207	0.277	0.939	-0.05	-0.104
Days taken to 50% flowering	P	0.073	0.119	-0.025	0.219	-0.008	-0.012
	G	0.074	-0.1	0.344	0.381	0.019	-0.059
Days from fruit set to maturity	P	0.125	0.149	-0.011	0.285	-0.003	-0.011
	G	0.14	-0.122	0.277	0.52	0.01	-0.055
Fruit length (cm)	P	0.083	0.204	-0.027	0.346	0.023	-0.008
	G	0.084	-0.176	0.413	0.657	-0.066	-0.04
Girth of the fruit (cm)	P	-0.017	0.124	-0.01	-0.022	0.017	0.003
	G	-0.023	-0.102	0.1	-0.04	-0.052	0.013
Pedicel length (cm)	P	0.02	0.068	-0.009	-0.043	0.006	0.002
	G	0.022	-0.067	0.002	-0.074	-0.016	-0.002
No. of fruits per plant	P	0.755	0.026	-0.012	-0.111	0.007	0.007
	G	0.669	-0.023	0.058	-0.196	-0.019	0.039
Fresh weight of the fruit (g)	P	0.047	0.424	-0.046	0.547	-0.013	-0.006
	G	0.049	-0.313	0.59	1.023	0.03	-0.018
Dry weight of fruit (g)	P	0.101	0.219	-0.088	0.311	-0.007	-0.009
	G	0.052	-0.251	0.735	0.843	0.032	-0.044
No. of seeds per fruit	P	-0.094	0.259	-0.031	0.895	-0.012	-0.019
	G	-0.086	-0.209	0.404	1.532	0.033	-0.09
Capsaicin content (mg)/100 g fruit	P	0.064	-0.061	0.007	-0.127	0.087	-0.002
	G	0.058	0.043	-0.106	-0.231	-0.221	-0.007
Ascorbic acid content (mg)/100 g fruit)	P	-0.113	0.054	-0.015	0.341	0.004	-0.05
	G	-0.127	-0.028	0.158	0.68	-0.008	-0.204

This may be explained on the basis that such characters were highly influenced by environment and thus had fortification of desirable genes in a specific manner. Such unstable linkages lead to genetic slippage with other yield components once the environmental effect is nullified.

A field screening of the collected germ plasm towards leaf curl complex revealed that only two genotypes viz. BCC 28 (18) and Ankur 228 were found to be resistant while eight others were moderately resistant. Rest of the genotypes were moderate to highly susceptible. The coefficient of infection ranged from 8.00 to 97.54 for different genotypes, the maximum being observed in Baddy 304 while the minimum was observed in BCC 28 (18). Similar findings were made by Munshi and Sharma (13). Leaf curl resistant varieties may be developed by crossing a resistant parent with a susceptible one but having good agronomic features followed by selection in the segregat-

ing generation having a good population.

Table 5. Reaction of chilli genotypes against leaf curl complex under natural epiphytotic condition. *PDI (Percent Disease Intensity) = (Number of diseased plant/Total number of plants observed) × 100. R—Resistant ; MR—Moderately resistant ; MS—Moderately susceptible ; S—Susceptible ; HS— Highly susceptible.

Genotype	Avg sever- ity grade (0-4)	Respo- nse value (RV) 0-1	Coeffici- ent of infec- tion Rea- ction		
			PDI*	(RV×PDI)	
Canning Bullet	1	0.25	76.21	19.05	MR
BCC-49 (42)	1	0.25	57.89	14.47	MR
BCC-28 (18)	1	0.25	32.00	8.00	R
BCC-12 (sel)	1	0.25	52.63	13.16	MR
Roshni	2	0.50	33.67	16.84	MR
BCC-15 (30)	2	0.50	47.62	23.81	MS
BCC-27 (28)	2	0.50	26.67	13.34	MR
BCC-30	2	0.50	31.82	15.91	MR
Aminpur Bullet	3	0.75	78.63	58.97	S
Kuyemuri	3	0.75	83.79	62.84	S

Table 5. Continued.

Genotype	Avg severity grade (0-4)	Response Value (RV)	Coefficient of infection PDI* (RV×PDI)	Reaction	
Ankur-228	3	0.75	11.76	8.82	R
BCC-28 (int)	3	0.75	16.67	12.51	MR
BCC-54 (sel)	3	0.75	21.74	16.31	MR
Krishna Small	4	1.00	94.65	94.65	HS
Morigaon Jhalakia	4	1.00	93.87	93.87	HS
Wonder Hot	4	1.00	91.74	91.74	HS
Damkal	4	1.00	87.45	87.45	HS
Teja	4	1.00	96.28	96.28	HS
Goli	4	1.00	92.19	92.19	HS
Baddy-304	4	1.00	97.54	97.54	HS
KVK-2	4	1.00	90.77	90.77	HS
KVK-1	4	1.00	89.65	89.65	HS
Dalkhola	4	1.00	93.91	93.91	HS
KA-2	4	1.00	26.98	26.98	MS
Dalkhola-2	4	1.00	95.68	95.68	HS
Dalkhola-3	4	1.00	91.32	91.32	HS
Dalkhola-4	4	1.00	94.87	94.87	HS
BBC-49 (var)	4	1.00	92.43	92.43	HS
BCC-61	4	1.00	93.58	93.58	HS
KES-2013	4	1.00	33.33	33.33	MS

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